Lagoon Ecology of Central Coast Steelhead and Tidewater Goby

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Late spring and summer beach development builds a full or partial sandbar across most central California stream mouths, producing summer lagoons. In wetter years (1986, 1995, 1997-9) the extensive loss of beach sand results in later development of the bar, and in some wet years (1998) high summer inflows result in periodic over-topping and breaching of the sandbars of some lagoons. In drier years (1987-1991, 2001) sandbar formation is usually earlier, but may be delayed at some stream mouths because of scarcity of tidal sand. Freshwater inflows after sandbar formation raise lagoon levels and greatly increase lagoon size and habitat variety (especially by flooding marshland vegetation adjacent to lagoons). Inflows also convert the lagoon towards fresh water, with the surface freshwater layer thickening and the bottom saltwater layer percolating through the bar. Larger lagoons, or lagoons with substantial amounts of salt water present at the time sandbar formation, require more inflow and/or a longer time to convert to fresh water. Lagoons fully converted to fresh water are generally relatively cool, well-mixed, and suitable for steelhead rearing. Brackish lagoons, with insufficient inflows after sandbar formation, remain stratified unless mixed by strong winds (lower Pajaro or Salinas River lagoons); water temperatures are high and dissolved oxygen levels often low in the bottom saltwater layer, generally producing low invertebrate abundance and poor rearing conditions for steelhead.

Plankton blooms, filamentous algae and rooted aquatic vegetation can support abundant invertebrates as food for lagoon fish, including steelhead. However, the plants can also produce poor dissolved oxygen conditions overnight or during prolonged foggy periods. These problems are relatively minor in well-mixed (freshwater or windy) lagoons, even when nutrient levels and vegetation abundance are high (lower Salinas River lagoon). Destratifying lagoons is more important for improving water quality than is nutrient or vegetation control. Shallow, productive lagoons converted to freshwater (Soquel Creek) can produce numerous, fast-growing steelhead, despite dense algal and rooted vegetation growth.

Periodic natural or artificial breaching of sandbars in summer reverses the freshening process, and sandbar re-formation produces salinity stratified conditions, with resultant warm and hypoxic bottom conditions unsuitable for benthic invertebrates and for steelhead. Open lagoons can sometimes provide some suitable habitat for steelhead near the tidally mixed mouth, but the substantially reduced remainder of the lagoon tends to be stratified, warm and relatively unproductive. Partially closed lagoons tend to have warm, stratified conditions except every two weeks when very high tides cool and mix the lagoon.

Steelhead in most stream habitats in the central coast grow slowly in late summer when streamflows are low and have to spend two years in freshwater. However, in well-mixed, productive lagoons abundant steelhead can often grow nearly as fast as in a hatchery, reaching sizes suitable to enter the ocean after one summer. In some years and watersheds a majority of the watershed smolt production may come from the lagoon (Pescadero in 1986). However, coho, which are scarce in the central coast, apparently rarely use lagoons for summer rearing because of the relatively high water temperatures. Even for steelhead and coho reared in streams, estuary/lagoon systems can be important as feeding areas and saltwater transition areas for smolts before entering the ocean.

Tidewater gobies tolerate a wide range of salinity (1-30+ ppt) and water quality conditions, but generally require sandbar closure to produce the calm lagoon conditions that promote their summer population explosions; ecologically they are a “lagoon goby” rather than a “tidewater goby”. Tidewater gobies also depend upon calm backwaters as refuges against storm flows and/or draining of small lagoons when the sandbar is opened in winter. Tidewater gobies are still present in the relatively natural Corcoran, Moores, Wilder, Baldwin and Laguna creek lagoons. They are apparently periodically lost and recolonize Aptos, Soquel and Moran lagoons, which provide poor winter refuges in flood years. They are absent from the Salinas and Carmel River lagoons, although habitat now appears suitable to support them. They have apparently been lost from the Pajaro River and Waddell creeks; at Waddell the loss was due to lack of backwater refuges during winter floods.

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small lagoons when the sandbar is opened in winter. Other fresh and saltwater fishes can heavily use lagoons, depending upon salinity conditions.

LAGOON ECOLOGY OF CENTRAL COAST FISHES

The estuaries/lagoons at the mouths of central and southern California streams have been highly modified by adjacent agricultural and urban development. In addition, they receive the accumulated impacts of water diversion, sedimentation and pollution discharges within the watersheds. Despite historical impacts, these estuaries can provide potentially valuable habitat for aquatic invertebrates, fishes and the wildlife dependent upon them. The relative value of individual estuaries varies with size, tidal action, depth, salinity and water quality. These features not only vary between estuaries, but also vary within estuaries on a seasonal and year-to-year basis. Based upon studies of 18 estuaries in San Mateo, Santa Cruz and Monterey counties, this paper outlines some of the important factors in the functioning of estuaries. It also describes the implications of estuarine function for fish, including for steelhead (*Oncorhynchus mykiss*) and tidewater goby (*Eucyclogobius newberryi*), two federally listed endangered or threatened species.

LAGOON FUNCTION

Sandbar Formation and Destruction

Central and southern California streams are relatively small and occupy seasonally dry watersheds. Therefore in late spring or summer the raising and widening of the beach by low energy waves forms a sandbar across most streams forming a fully or partially closed lagoon.

wave dynamics
sand abundance
inflows
coastline shape